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NOTE

Asian Tiger Mosquito, *Aedes albopictus* (Skuse) (Diptera: Culicidae), Larvae in Pitchers of *Nepenthes ventricosa* Blanco (Nepenthaceae) in Virginia

Cultivating unusual exotic plants has been popular with horticulturists since Darwin's time. These include Old World tropical pitcher plants belonging to the genus *Nepenthes* (Nepenthaceae). Since their discovery by Europeans in Madagascar in the 17th century, over 60 species of *Nepenthes* have been described (Clark 1997). Many of the species are restricted to the tropical rain forests of Malaysia and Borneo where their vines attach to trees and extend vertically above the ground (Clark 1997, 2001). Others are found in drier open areas where they are non-climbers. Because *Nepenthes* is dioecious, species sometimes hybridize in nature. Nurserymen and collectors also create dozens of hybrids and cultivars.

The modified traps or pitchers of *Nepenthes* form at the ends of tendrils emanating from the tips of the leaves and they vary considerably in size and shape. Not all leaves form traps. The pitcher is a cuplike structure with a lip. It has a ribbed upper rim, a waxy zone and a pool of fluid which assists in the breakdown of prey items (Adams and Smith 1977). Prey are attracted to the traps by a combination of cues including the release of extrafloral nectar, purple markings on the body and rim of the trap, odors released by the decaying matter in the fluid-filled traps, and leaf morphology. Some insects attracted to the traps crawl along the lip of the cuplike leaves and fall into and drown in the liquid contents. In time they are degraded by a combination of leaf-produced enzymes, microorganisms, and associated invertebrates. The invertebrates include rotifers, protozoa, crustaceans, and larvae of several families of Diptera including mosquitoes (Kitching 2000).

Meadowview Biological Research Station (MBRS) in Caroline County, Virginia, maintains living collections of many species of pitcher plants. One of the species that is maintained in large numbers in the collections is the purple pitcher plant, *Sarracenia purpurea* L., which occurs naturally in Virginia. Found living in *S. purpurea* leaves are larvae of the species-specific mosquito, *Wyeomyia smithii* (Coq) (Buffington 1970). During the summer at MBRS in the area of the *S. purpurea* plant beds, several *Nepenthes* plants are suspended from a chainlink fence. Although *Wy. smithii* larvae were not expected to be found in the *Nepenthes* leaves, we decided to test this by sampling water from leaves of *N. ventricosa* Blanco. We found that several leaves contained mosquito larvae. To determine the species, we reared the immature specimens to adults. To broaden the scope of the initial observation, we contacted some local *Nepenthes* growers to see if other species of *Nepenthes* contained mosquito larvae.

The plants studied in this investigation were maintained outdoors during the warmer months and indoors during the winter months. Seventeen leaves were sampled from two *N. ventricosa* plants at the MBRS and leaves from one plant at Fredericksburg, Spotsylvania County, Virginia. At that location six additional species of *Nepenthes* were also sampled including *N. ampullaria* Jack., *N. alata* Blanco, *N. rafflesiana* Jack., *N. coccinea* [(*N. rafflesiana* × *N. ampularia*) × *N.*

mirabilis (Lour.) Druce], *N. albomarginata* Lobb & Lindl, and *N. truncata* Macfarlane.

All samples were collected in October, 2004. Fluid in each leaf was stirred with a tapered spatula to re-suspend debris and organisms. The suspended contents were removed using a pipette (0.4 cm internal diameter) with an attached rubber bulb. This material was placed in a 50 ml conical plastic tube and transported to the laboratory.

Samples were processed within 24 h of collection. In the laboratory, each sample was assigned an accession number and was examined for mosquito larvae using a dissecting stereo microscope. The water was also checked for rotifers, copepods, and other invertebrates.

Samples containing mosquito larvae were transferred to 40 ml glass Syracuse dishes that contained 20 ml of leaf water. The larvae were fed brewers yeast. Each day the samples were checked and pupae were removed. Each pupa was reared individually in a 50 ml. screw cap, conical centrifuge tube that contained 1 ml of leaf water. All specimens were labeled with individual accession numbers. The dates of pupation and emergence were recorded. Adult mosquitoes were removed and frozen.

Voucher specimens were preserved and labeled *N. ventricosa* study [2004-IX-27-(76 & 77; 2004-X-10-27]. They are deposited at the Georgia Museum of Natural History, University of Georgia, Athens, Georgia.

From the two *N. ventricosa* plants at the MBRS Station, out of 17 leaves sampled, five leaves contained 34 mosquito larvae and pupae. A total of 19 adults were reared out of this material, and the remaining larvae and pupae were preserved 70% ethyl alcohol. From the twelve leaves sampled from Fredericksburg, one contained 16 mosquito larvae. Twelve adults were reared from this material. All reared mosquitoes were identified as *Aedes albopictus* (Skuse), the Asian tiger mosquito (Darsie and Ward 2005).

In addition to *N. ventricosa*, six other species were sampled at the Fredericksburg site, namely *N. ampullaria*, *N. alata*, *N. rafflesiana*, *N. coccinea*, *N. albomarginata*, and *N. truncata*. None of the water samples from these six species contained mosquito larvae.

Aedes albopictus was first documented in the United States in Harris County, Texas, in 1985 (Sprenger and Wuithiranyagool 1986). The following year this mosquito was detected throughout the southeastern states. Authorities believe the mosquito entered the United States several years before its first detection based on its distribution and subsequent spread. *Aedes albopictus* and other exotic mosquito species were intercepted in shipments of used tires entering the United States from Asia (Moore et al. 1988). Today this mosquito is well established in the United States and has been documented in 26 states (Moore 1999).

In temperate climates, *Ae. albopictus* overwinters in the egg stage (Lyon and Berry 1991). The eggs are laid singly on the sides of water holding containers. The eggs usually hatch upon submersion. The larvae feed on fine organic matter in the water. At room temperature and with adequate food supply, the larval stage lasts five to ten days and another two days in the pupal stage.

The Asian tiger mosquito is a major pest species. Adults feed opportunistically and aggressively during the daytime on humans, as well as a wide variety of mammalian species, including natural hosts for several arboviruses of humans and animals. For example, *Ae. albopictus* has been shown to be a competent vector of La Crosse virus and dengue. Although not the primary epidemic vector of dengue, it may be involved in the maintenance cycle of dengue (Moore et al. 1988).

Nepenthes ventricosa is native to the Philippine Islands (Cheers 1992). The natural distribution of *Ae. albopictus* includes the Philippine Islands (Knight and Hull 1952). If the two species occur naturally in the same area, they might be associated together when introduced into a new region of the world.

Aedes albopictus is primarily found along the edges of forests. In North America, it has quickly adapted to breeding in both natural and artificial containers. In some situations, *Ae. albopictus* displaces existing species. For example, interspecific experimental studies by Livdahl and Willey (1991) between the eastern tree-hole mosquito, *Ae. triseriatus* (Say) and *Ae. albopictus*, showed the latter always prevailed.

The presence of *Ae. albopictus* larvae in the leaves of *N. ventricosa* documents the adaptability of this species to exploit a variety of phytotelmata (structures formed by non-aquatic plants that impound rainwater). Lounibos et al. (2003) reported that *Ae. albopictus* occurs in the water-holding tanks and axils of ornamental bromeliads found in gardens in Florida. The numbers of *Ae. albopictus* in ornamental bromeliads were significantly higher in northern Florida sites than southern sites.

It is interesting that leaves from *N. ventricosa* plants from two different locations contained *Ae. albopictus* larvae. We have no explanation why none of the water-filled leaves of the other species of *Nepenthes* contain mosquito larvae. One hypothesis would be that there are chemical cues that attract *A. albopictus* to *N. ventricosa* or that the other species exhibit some surface compound, possibly a wax, that is a deterrent to the Asian tiger mosquito. While collecting samples we did observe that many samples smelled putrid. Closer inspection of the leaves revealed that they contained large numbers of dead insects primarily earwigs (Dermaptera). It appeared the leaves were eutrophic.

Nepenthes can be started from cuttings or from seed. Collectors frequently amass large living collections of multiple species and they are placed around patios and backyards during the summer months. Unfortunately cultivated *Nepenthes* may provide breeding sites for the *Ae. albopictus* as well as other container-breeding species. In the fall, local plants have to be brought indoors to protect them from freezing. Trimming the pitchers off is one easy method to prevent bringing mosquitoes indoors during the winter months.

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